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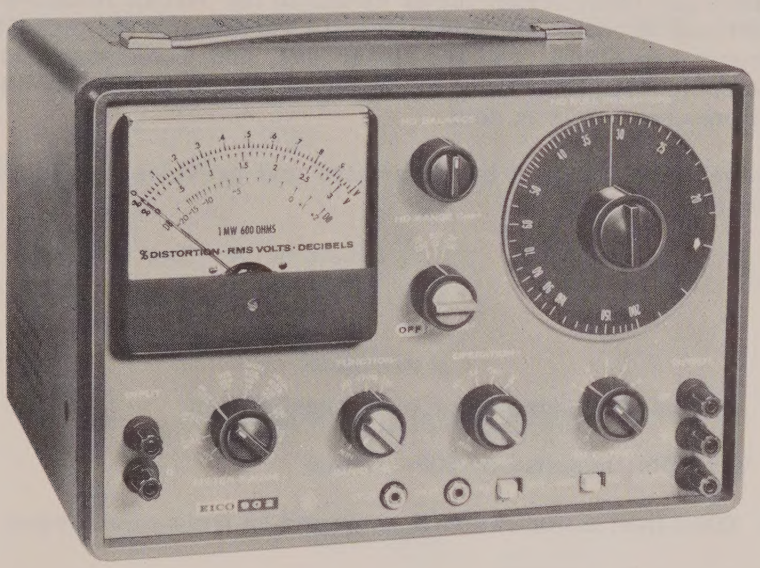
IM / Harmonic Distortion Meter
& AC VTVM

EICO®

Model 902

INSTRUCTION MANUAL

MP MASTER
MA35561



SECTION I

DESCRIPTION & SPECIFICATIONS

DESCRIPTION

The EICO 902 is a unique audio test instrument combining IM and Harmonic Distortion Meters, sensitive AC VTVM and db meter in one compact package. Designed and constructed to laboratory requirements, it offers the stability and accuracy needed for critical measurements in audio research, design, and development. Yet, its ease and speed of operation make it ideal for in-production testing and quality control, and servicing.

For HD measurement, the 902 incorporates a continuously variable 20-20,000 cps Wien Bridge rejection filter (in three ranges). A high quality tuning capacitor, with 6:1 vernier, eases frequency setting. Less than 0.7V input is required for measurement. 0.3% distortion is read full-scale. Internal distortion is less than 0.1%.

For IM distortion measurement the 902 incorporates a 7kc oscillator for the high frequency source and an additionally filtered line frequency signal, for the low frequency source. Selection is provided on the panel of either 4:1 or 1:1 LF to HF voltage ratios. When desired, external low frequency sources up to 400 cycles and external high frequency sources down to 2kc may be fed to the mixing bridge through panel jacks that switch out the internal sources when used. Less than 0.7V is sufficient input for IM distortion measurement. The high-pass filter is constant-K with toroidal coils. 0.3% distortion is read full-scale. Residual distortion is approximately .05%.

Used as an AC VTVM, the 902 provides a highest range of 300V and a lowest range of 10mV with uniformly excellent response at all levels (60db frequency-compensated input attenuator on ranges above 3V). A 10db step attenuator after the input cathode follower reduces

the input voltage to within the basic sensitivity range. This voltage is applied to an R-C coupled 2-stage amplifier with a full diode bridge meter circuit in the overall feedback loop. A single sensitivity adjustment and no response adjustment is required. The AC VTVM section is employed in all instrument functions, and the linear 0-1, and 0-3 meter scales are used for all measurements. A decibel scale (-20 to +2) is provided also, based on 0db = 1mw in 600 ohms and permitting power measurements in dbm.

The full-wave power supply is V-R tube regulated and provides d-c filament bias and a hum-balance potentiometer.

SPECIFICATIONS

IM DISTORTION

Ratios of LF to HF: 4:1 and 1:1, selected by front panel switch

Test Signal Output: 0-5 volts, adjusted by 600Ω L-pad

Output Termination: 600Ω internal or external, selected by front panel switch

Impedance at INPUT Terminals: 500KΩ

Minimum Input Level for Measurements: 0.7 volt

Distortion Ranges: 0.3, 1, 3, 10, 30%

Accuracy: ±5% of full scale

HARMONIC DISTORTION

Fundamental Frequency Ranges: 20-200, 200-2,000, 2,000-20,000 cycles

Impedance at INPUT Terminals: 500KΩ

Minimum Input Level for Measurements: 0.7 volts

Distortion Ranges: 0.3, 1, 3, 10, 30, 100%

Accuracy: ±5% of full scale

AC VTVM

Ranges: .01, .03, 0.1, 0.3, 1, 3, 10, 30, 100, 300 volts rms. Also db scale of -20 to +2

Impedance at INPUT Terminals: 2 Megohms shunted by 15mmf

2. Frequency Response: ±0db from 10 cycles to 100kc. 3db down at 300kc

Accuracy: ±4% of full scale

Freq. Response

1-26-66
T.S.

10 cps	-5%
12 cps	-3%
400 "	-OK
40Kc	-OK
60Kc	--3%
100Kc	-6%

MISCELLANEOUS

Tube Complement: 1-12DW7, 1-12BY7, 2-ECF80, 1-EF86, 1-6D10, 1-6C4, 1-0A2, 1-6X4

Power Requirements: 105-130 volts ac, 60 cycles, 60 watts

Size: 12-1/2 x 8-1/2 x 10-1/2" (HWD)

Weight: 18 lbs.

Export Model: 115 & 230 VAC, 60/50 cycles

SECTION II

OPERATING INSTRUCTIONS

CAUTION

Connect the instrument to a 115 VAC, 60 cycles line only, unless you have the export model which can be connected for operation either from 115 or 230 VAC lines, 60 or 50 cycles.

The blocking capacitor in the input circuit of the instrument is rated at 500 volts. This means that the sum of the dc voltage and the peak value of the AC voltage applied to the input of the instrument must not exceed 500 volts. Higher voltage will result in breakdown of the input circuit capacitor.

FUSE

An extractor post fuseholder on the rear apron contains a cartridge fuse in the primary circuit of the power transformer. The fuse is a Type 3AG standard fuse, rated 1 ampere.

NOTES

When the instrument is turned off, the meter pointer should be at zero. If not, see Section 4, paragraph 4-3 "Meter Mechanical Zero Adjust".

In VTVM operation, the meter will read stray pick-up voltages, particularly noticeable on the low ranges, when the input terminals are not connected to a source. This in no way affect the accuracy of the instrument when measurements are being made.

2-1. INTERMODULATION DISTORTION MEASUREMENT

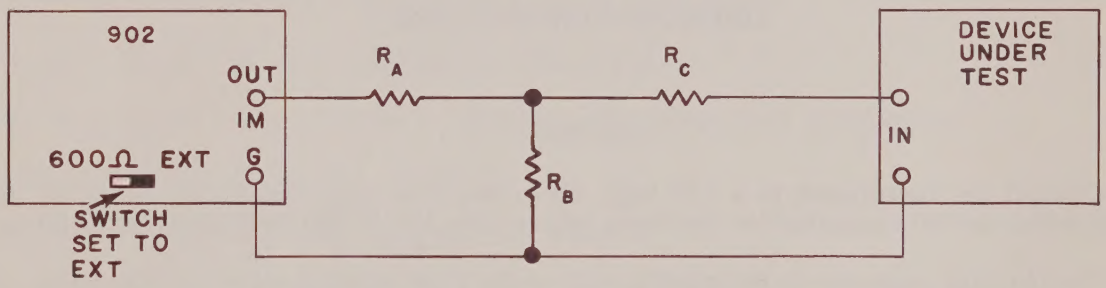
a. CONNECTIONS TO DEVICE UNDER TEST

The test signal is fed from the IM OUTPUT terminals to the input of the device in accordance with the considerations given below. The signal from the output of the device is fed to the INPUT terminals, having an input impedance of 500K ohms, which is a negligible load for normal circuits. Of course, the device must be terminated with the correct load resistor, or a properly matching transducer if more realistic conditions are desired.

If the device has a high impedance input (amplifier grid, etc.), set the 600Ω-EXT switch to 600Ω to terminate the output in 600Ω. If the device has a transformer input, set the 600Ω-EXT. switch to EXT. (no termination) and supply a matching network between the IM OUTPUT terminals and the input terminals of the device appropriate to the nominal input impedance. See Fig. 2-1.

If isolation between the 902 and the device is required (cases where the input and output of the device do not have a common terminal), then a high quality isolation transformer* must be used to couple the 902 IM OUTPUT to the input of the device. If the input is high impedance, set the 600Ω-EXT switch at EXT and shunt the input of the device with a 600 ohm resistor. If the device has a transformer input, then set the 600Ω-EXT switch at EXT and interpose the appropriate matching network between the isolation transformer and the device input. See Fig. 2-2.

*UTC Type A-20 with A-33 shield (or equivalent). Use 600/500Ω pri, 600/500Ω sec.



Device Input Impedance (Ohms)	Ra (Ohms)	Rb (Ohms)	Rc (Ohms)
600	200	820	200
500	270	750	100
250	470	330	0
150	510	180	0
50	560	56	0

Figure 2-1. Matching Networks (nearest RETMA values)

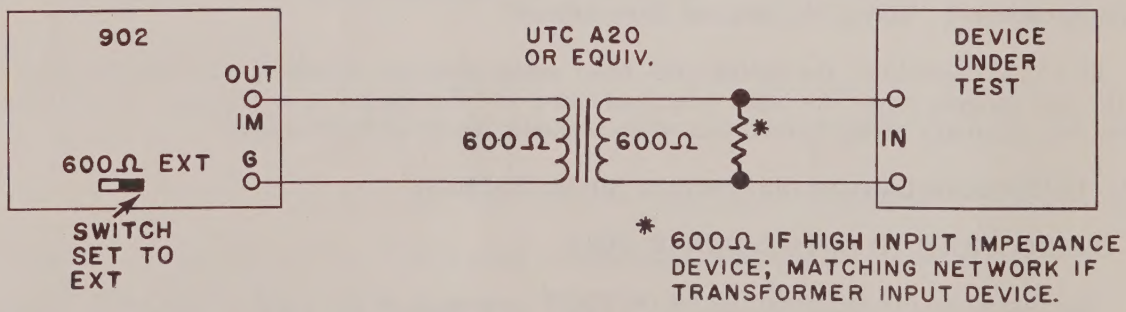


Figure 2-2

b. USING EXTERNAL HIGH AND/OR LOW FREQUENCY GENERATORS

The test frequencies provided (60 cps & 7kc) are the standard test frequencies now in use by the high fidelity industry. A more stringent test of wide-band amplifiers might be obtained

with a 40 cps low test frequency. On the other hand, an amplifier with limited low frequency response should be tested using a low test frequency of 100 to 150 cps, depending on the low frequency cut-off. Depending on the high frequency cut-off, the high test frequency may be as low as 2kc. If test frequencies other than 60 cps and 7kc are desired, connect the external high and/or low frequency generators to the HF and LF panel jacks respectively. The type of connector required is a Switchcraft No. 750 "Tini-Plug" or the equivalent. The low frequency generator is set to the desired test frequency between 10 and 400 cps and to maximum output. The high frequency generator is set to the desired test frequency between 2 and 20kc and the output level to 6 volts into 600 ohms. (The latter can be done during the IM measurement procedure when the OPERATION switch is set at HF.) Note that input impedance of both the HF and LF inputs is 600 ohms, and that the external generators must be capable of delivering at least 6 volts into 600 ohms with low distortion.

c. PRELIMINARY CONTROL SETTINGS

The setting of the 600Ω-EXT. switch is discussed in paragraph a. above, and must be made accordingly. The standard LF:HF ratio for IM testing is 4:1 and this is therefore the normal setting of the IM 1:1-4:1 switch. The IM 1:1 position would be used primarily for a more severe test.

d. EQUIVALENT SINE-WAVE POWER VS. VOLTAGE & LOAD RESISTANCE

In IM measurements, it is very important that the level of developed output power be properly calculated from the RMS voltage reading on the meter, as otherwise the amplifier may be badly misrated as to the power it can deliver at a given level of distortion. The term "equivalent sine-wave power" (abbreviated ESWP) is used to denote the equivalent amount of single tone sine wave power to the two-tone IM test signal power on an equal peak power basis. Power is calculated according to the relationship

$$P = \frac{V^2}{R} \quad \text{(watts)}$$

where V is the meter reading in volts RMS and R is the load impedance in ohms. In IM testing with a test signal having a 4:1 LF:HF ratio, the power calculated by the relationship above must be multiplied by a factor of 1.47 to determine the ESWP. In practice, it is desired to know the output voltage across a specific load that the input signal to the amplifier must be adjusted for in order to obtain an IM reading at a given ESWP level. Since,

$$ESWP = (1.47)(V^2/R)$$

See BACK PAGE

then $V = 0.825\sqrt{(ESWP)(R)}$

This last relationship has been used to calculate tables of voltage vs. ESWP for various common load resistances. See Fig. 2-6.

e. IM TEST PROCEDURE

1. Set FUNCTION switch at IM, OPERATION switch at HF.

2. Set METER RANGE switch at 10V and read meter (5-6V RMS). (If an external HF generator is being used, set the generator output level control for a reading of 6V RMS on meter).

3. Set OPERATION switch at LF, and adjust LF LEVEL control for same reading as obtained in step 2, above.

4. Set FUNCTION switch at VTVM and adjust IM OUTPUT control for device output voltage (across the specific matching load used) that corresponds to the desired ESWP level of measurement. See Fig. 2-6. Note that the minimum voltage required at the INPUT terminals for IM measurement is 0.7V RMS.

5. Set FUNCTION switch at IM, OPERATION switch at CAL, METER RANGE switch at IM CAL, and adjust IM/HD CAL control for full-scale reading on 0-3 scale.

6. Set OPERATION switch at % and read IM distortion on meter in percent, with METER RANGE switch set at lowest possible range.

NOTE A: Repeat steps 4 through 6 for distortion measurement at each desired level of ESWP. Steps 1 through 3 need not be repeated as long as the LF LEVEL control setting is not disturbed.

NOTE B: In production testing, it may be considered adequate to check IM at only one output level. In this case the required procedure for testing the second and subsequent units, starting with controls set as at the conclusion of testing the first unit, is as follows: 1. Return the FUNCTION switch to the VTVM position, and adjust the IM OUTPUT control for the identical device output voltage used in step 4, above. 2. Set the FUNCTION switch at IM, and read IM distortion on the meter with the METER RANGE switch set at the lowest possible range.

2-2. HARMONIC DISTORTION MEASUREMENT

a. CONNECTIONS TO DEVICE UNDER TEST

In HD measurement, a single-frequency sinusoidal test signal between 20 and 20,000 cps is applied to the input of the device from an external audio generator. The signal from the output of the device is fed to the INPUT terminals having an input impedance of 500K ohms, which is a negligible load for normal circuits. Of course, the device must be terminated with the correct load resistor, or a properly matching transducer if more realistic conditions are desired.

The external audio generator used must have inherently low distortion and high signal-to-noise ratio. The manner of connecting the audio generator to the input of the device must be such as avoid increasing distortion of the input signal as well as obtaining the maximum possible signal-to-noise ratio of which the generator is capable. The output termination requirements of the generator as well as the input impedance of the device must be taken into consideration, and proper matching pads provided if required. The required information is normally provided in the operating manual of the audio generator.

In cases where the input and output of the device do not have a common terminal, the external audio generator must be connected to the device input through a high quality isolation transformer*, and a ground lead connected from the ground terminal of the audio generator to the ground terminal of the 902. See Fig. 2-3.

*UTC Type A20 with A-33 shield (or equivalent). Use 600/500Ω pri, 600/500Ω sec.

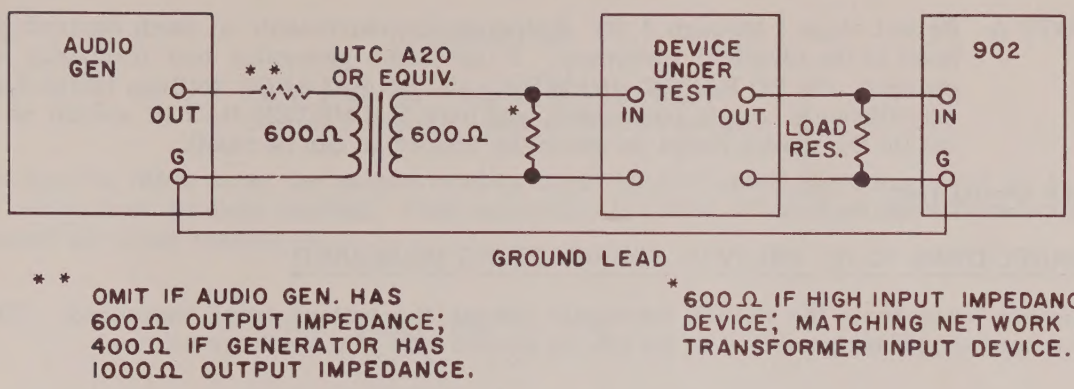


Figure 2-3

b. POWER VS. VOLTAGE & LOAD RESISTANCE

In HD measurements, single-frequency sine wave test signals are employed. Output power is calculated according to the relationship

$$P = \frac{V^2}{R} \quad \text{(watts)}$$

where V is the meter reading in volts RMS and R is the load impedance in ohms. In practice, it is desired to know the output voltage across a specific load that the input signal to the amplifier must be adjusted for in order to obtain in HD reading at a given power level. From the relationship above

$$V = \sqrt{PR}$$

This last relationship has been used to calculate tables of voltage vs. power for various common load resistances. See Fig. 2-7

c. HD TEST PROCEDURE

1. Set FUNCTION switch at VTVM.

2. See Fig. 2-7. for output voltage corresponding to desired output power level across specific load resistance. Set RANGE switch at appropriate range, and adjust external audio generator and/or device gain control for required output voltage read on meter.

3. Set FUNCTION switch at HD, OPERATION switch at CAL, METER RANGE switch at HD CAL, and adjust IM/HD CAL control for full-scale reading on 0-1 scale.

4. Set OPERATION switch to %.

5. Set HD RANGE switch to frequency range including test frequency.

6. Adjust the HD NULL and HD BALANCE controls alternately for minimum meter reading while progressively going to lower range positions of the METER RANGE switch. On the lowest possible range, use the HD BALANCE control exclusively to obtain the minimum, and read the minimum as percent harmonic distortion.

NOTE A: Repeat steps 1 through 4 for distortion measurements at each desired power level at the identical frequency. If the audio generator test frequency is not changed, the HD RANGE, HD NULL, and HD BALANCE settings (steps 5 and 6) may likewise remain unchanged, and only the METER RANGE switch need be set (to the lowest range on which the distortion can be read).

2-3. AC VTVM USE

a. CONNECTIONS TO AC VOLTAGE SOURCE BEING MEASURED

Connect leads from the INPUT terminals across the voltage being measured. The G terminal lead should be connected to the low or ground side of the voltage source.

CAUTION

When measuring line voltage, there is a 50% chance that the instrument chassis will be connected to the "hot" side of the line. This can be dangerous and due caution should be exercised.

b. AC VOLTAGE MEASUREMENT

1. Set FUNCTION switch at VTVM.

2. Set METER RANGE switch to lowest range that is higher than anticipated voltage value. Use next higher range at first, if there is any doubt. Read voltage on meter on lowest possible range for best accuracy.

NOTE: The instrument responds to the average value of the wave, but is calibrated in RMS value of a sine wave (1.11 times the average value). If the sine wave is partially distorted, the accuracy of the RMS readings will be affected (as would be the case with any average responding device). However, the distortion must be quite severe before the accuracy is significantly affected, i.e., 20% 2nd harmonic distortion will cause readings up to 2% low, 50% up to 10% low; 10% 3rd harmonic distortion will cause readings up to 4% high or low, 20% up to 6% below. There is no fixed correction because the reading varies with the phase relationship between the fundamental and harmonic frequencies. It should be emphasized that the foregoing information does not constitute a limitation on the use of the instrument, but simply indicates that observation of the waveform being measured on an oscilloscope can alert the user to possible inaccuracy in the measurement.

c. VOLTAGE RATIO/POWER RATIO DB READINGS

The difference between two voltmeter readings can be read as a difference between two decibel scale readings. This difference in db is a measure of the ratio of the two voltages. The two measurements can be taken across different impedances without affecting the validity of the difference reading for measuring pure voltage ratio (not power).

If the load impedance is the same for both readings, than the difference on the decibel scale is a measure of power ratio, as well as voltage ratio.

Since db readings are difference readings, one need only know that there is a 10db interval between ranges. For example, if the second reading is made on the higher voltage range, you must add 10db to the second scale reading before subtracting the first from the second reading to determine the db difference.

EXAMPLE

First reading: +1db on the 3V range
Second reading: -5db on the 10V range

To find the difference, the second reading must be corrected for being read on the next higher range than the first reading. This correction is +10db. Therefore the difference between the second and first reading is

(-5db + 10db) -1db = 4db

d. DBM READINGS WITH VOLTMETER

The decibel scale is drawn on the basis of a 600 ohm load impedance, and a zero voltage reference level of 0.775 volt*. In the voltmeter function, this scale reads directly in dbm on the 1V range when the load impedance is 600 ohms. On other ranges, 10db per range must be added or subtracted for each range above or below the 1V range. With other impedances, a correction must be added or subtracted according to the graph of Fig. 2-4. This facility is valuable when it is required to make power measurements in loads other than the standard wattmeter loads (4, 8, 16, or 600 ohms). To convert dbm values into milliwatts, refer to the table of Milliwatts vs. DBM, Fig. 2-5.

EXAMPLE

With a load impedance of 200 ohms, a scale reading of -6dbm is obtained on the 10V range. As the 10V range is two ranges above the 1V range, 20db must be added to the reading as follows:

-6dbm + 20db = 14dbm

Consulting the graph of Fig. 2-2, we read the correction for 200 ohms load impedance as +5db. Adding in the impedance correction, we obtain the true dbm value:

14dbm + 5db = 19dbm

*This constitutes a power reference level of $(0.775)^2/600$ = 1 milliwatt

2-4. USE OF SCOPE TERMINALS

The scope connection terminals (SCOPE and G) are provided specifically to permit observation of the residual waveform after fundamental rejection in harmonic distortion measurement.

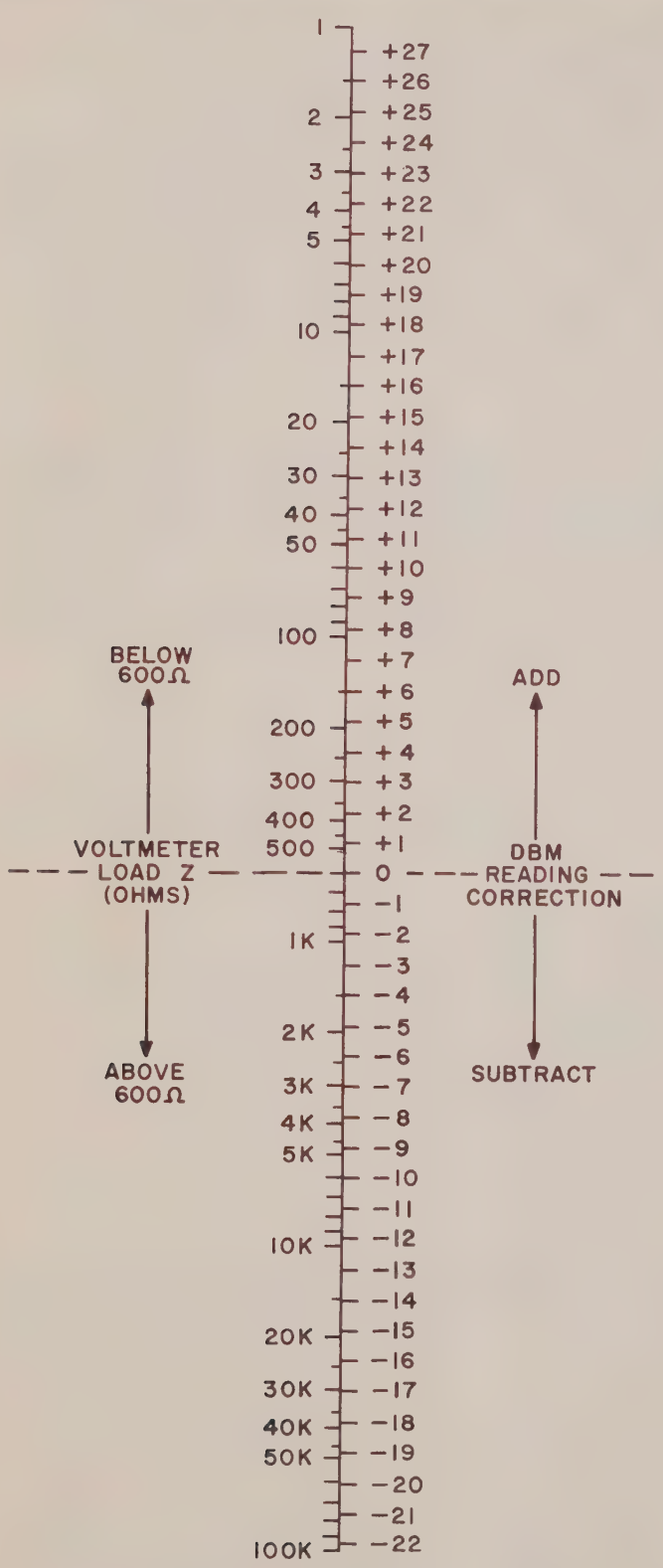


Figure 2-4. Nomograph of DB Corrections vs. Load Impedance for DBM Readings in VTVM operation.

Milliwatts	Level dbm
1.000	-0+
.794 3	1
.631 0	2
.501 2	3
.398 1	4
.316 2	5
.251 2	6
.199 5	7
.158 5	8
.125 9	9
.100 0	10
.079 43	11
.063 10	12
.050 12	13
.039 81	14
.031 62	15
.025 12	16
.019 95	17
.015 85	18
.012 59	19
.010 00	20
.003 16	25
.001 00	30
.000 316	35
.000 100	40
3.16×10^{-5}	45
1.00×10^{-5}	50
3.16×10^{-6}	55
1.00×10^{-6}	60
3.16×10^{-7}	65
1.00×10^{-7}	70
3.16×10^{-8}	75
1.00×10^{-8}	80

Figure 2-5. Table of Milliwatts vs. DBM for Power Readings in VTVM operation.

TABLES OF OUTPUT VOLTAGE VS. EQUIPMENT SINE WAVE POWER (ESWP) FOR COMMON LOAD RESISTANCES

(CALCULATED FOR IM DISTORTION MEASUREMENTS WITH LF:HF RATIO OF 4:1)

ESWP Watts \ R load (ohms) / dbm	3.2	4	8	16	30	50	125	150	200	250	500	600
1.00mw 0											.687	.640
1.26mw +1											.655	.717
1.59mw 2										.520	.736	.805
2.00mw 3									.522	.584	.827	.905
2.51mw 4									.586	.655	.929	1.01
3.16mw 5							.521	.572	.657	.735	1.04	1.14
3.98mw 6							.583	.640	.736	.823	1.17	1.28
5.01mw 7							.655	.718	.825	.922	1.31	1.43
6.31mw 8							.735	.807	.928	1.04	1.47	1.61
7.94mw 9						.520	.825	.906	1.04	1.16	1.65	1.80
10.0mw 10						.584	.925	1.02	1.17	1.31	1.85	2.02
12.6mw 11					.507	.655	1.04	1.14	1.31	1.46	2.08	2.26
15.9mw 12					.570	.736	1.17	1.28	1.47	1.65	2.33	2.55
20.0mw 13					.640	.826	1.32	1.44	1.65	1.85	2.62	2.86
25.1mw 14					.718	.926	1.47	1.61	1.85	2.07	2.94	3.21
31.6mw 15				.589	.806	1.04	1.65	1.81	2.08	2.32	3.30	.360
39.8mw 16				.660	.905	1.17	1.85	2.03	2.34	2.61	3.70	4.05
50.1mw 17			.525	.740	1.01	1.31	2.07	2.28	2.62	2.92	4.14	4.53
63.1mw 18			.589	.830	1.14	1.47	2.32	2.55	2.93	3.28	4.65	5.08
79.4mw 19			.660	.930	1.28	1.65	2.60	2.86	3.29	3.68	5.21	5.70
.100 20		.521	.740	1.04	1.43	1.84	2.92	3.20	3.68	4.12	6.87	6.40
.126 21	.523	.584	.830	1.17	1.60	2.07	3.27	3.60	4.13	4.61	6.55	7.17
.159 22	.587	.655	.930	1.31	1.80	2.32	3.67	4.03	4.64	5.20	7.36	8.05
.200 23	.659	.737	1.05	1.47	2.02	2.61	4.13	4.53	5.22	5.84	8.27	9.05
.251 24	.740	.827	1.18	1.66	2.27	2.93	4.63	5.09	5.86	6.55	9.29	10.1
.316 25	.828	.925	1.32	1.85	2.54	3.28	5.2	5.72	6.57	7.35	10.4	11.4
1.000 30	1.48	1.65	2.34	3.30	4.52	5.84	9.25	10.2	11.7	13.1	18.5	20.2

ESWP Watts \ R load (ohms) / dbm	3.2	4	8	16	30	50	125	150	200	250	500	600
2 33	2.10	2.34	3.30	4.67	6.40	8.25	13.1	14.2	16.5	18.5	26.1	28.6
3 34.8	2.56	2.86	4.04	5.72	7.82	10.2	16.0	17.5	20.2	22.6	32.0	35.0
4 36	2.96	3.30	4.67	6.60	9.05	11.7	18.4	20.2	23.4	26.1	39.0	40.4
5 37	3.31	3.69	5.22	7.39	10.1	13.1	20.6	22.6	26.1	29.2	41.3	45.2
6 37.8	3.62	4.05	5.72	8.09	11.1	14.3	22.6	24.8	28.6	32.0	45.2	49.5
7 38.4	3.91	4.37	6.18	8.21	12.0	15.5	24.5	26.8	30.9	34.5	48.8	53.5
8 39	4.17	4.66	6.61	9.35	12.8	16.5	26.2	28.6	33.0	36.9	52.3	57.3
9 39.5	4.42	4.95	7.00	9.90	13.6	17.5	27.6	30.4	35.0	39.2	55.3	60.7
10 40	4.66	5.21	7.39	10.5	14.3	18.4	29.2	32.0	36.9	41.3	58.4	63.9
11 40.4	4.90	5.46	7.75	11.0	15.0	19.3	30.9	33.5	38.9	43.3	61.2	67.0
12 40.8	5.11	5.71	8.10	11.5	15.7	20.3	32.0	35.0	40.5	45.2	63.9	70.0
13 41.1	5.32	5.95	8.40	11.9	16.3	21.0	33.3	36.4	42.0	47.1	66.5	72.8
14 41.5	5.52	6.17	8.73	12.4	16.9	21.8	34.5	37.8	43.7	48.8	69.0	75.6
15 41.8	5.71	6.39	9.03	12.8	17.5	22.6	35.7	39.1	45.2	50.5	71.4	78.3
20 43	6.60	7.38	10.5	14.8	20.2	26.0	41.2	45.2	52.2	58.3	82.5	90.3
25 44	7.38	8.25	11.7	16.5	22.6	29.2	46.2	50.5	58.3	65.2	92.3	102
30 44.8	8.09	9.03	12.8	18.1	24.7	32.00	50.5	55.3	64.0	71.4	102	111
35 45.4	8.73	9.76	13.8	19.5	26.7	34.5	54.6	59.8	69.0	77.2	110	120
40 46	9.34	10.5	14.8	20.9	28.6	36.9	58.3	64.0	73.8	82.5	117	128
45 46.5	10.0	11.1	15.7	22.1	30.3	39.1	61.9	67.8	78.3	87.5	124	136
50 47	10.5	11.7	16.5	23.3	32.0	41.2	65.2	71.5	82.5	92.2	131	143
60 47.8	11.5	12.8	18.1	25.6	35.0	45.2	71.4	78.3	90.3	102	143	157
70 48.4	12.4	13.8	19.5	27.7	37.8	48.8	77.2	84.6	97.6	110	155	169
80 49	13.2	14.8	20.9	29.6	40.4	52.2	82.5	90.4	105	117	165	181
90 49.5	14.0	15.7	22.1	31.3	42.8	55.3	87.5	96.0	111	124	175	192
100 50	14.8	16.5	23.3	33.0	45.4	58.3	91.7	102	117	131	184	202

TABLES OF OUTPUT VOLTAGE VS. SINGLE FREQUENCY SINE WAVE POWER FOR COMMON LOAD RESISTANCES

(FOR USE IN HARMONIC DISTORTION MEASUREMENTS)

POWER Watts / R load (ohms)	dbm	3.2	4	8	16	30	50	125	150	200	250	500	600
1.00mw	0											.710	.774
1.26mw	+1											.794	.868
1.59mw	2									.563	.630	.892	.975
2.00mw	3							.501	.550	.632	.706	1.00	1.09
2.51mw	4							.561	.616	.708	.791	1.12	1.23
3.16mw	5							.630	.691	.795	.889	1.26	1.38
3.98mw	6							.705	.775	.890	.995	1.41	1.54
5.01mw	7						.500	.791	.870	1.00	1.12	1.58	1.73
6.31mw	8						.562	.890	.976	1.12	1.33	1.78	1.95
7.94mw	9						.630	1.00	1.09	1.26	1.41	2.00	2.18
10.0mw	10					.548	.707	1.12	1.23	1.41	1.58	2.24	2.45
12.6mw	11					.615	.793	1.26	1.38	1.58	1.77	2.51	2.75
15.9mw	12					.690	.890	1.41	1.55	1.78	1.99	2.82	3.08
20.0mw	13				.565	.775	1.00	1.58	1.74	2.00	2.24	3.17	3.46
25.1mw	14				.633	.867	1.12	1.78	1.95	2.24	2.50	3.55	3.88
31.6mw	15				.712	.975	1.26	1.99	2.19	2.52	2.81	3.99	4.36
39.8mw	16			.566	.798	1.09	1.41	2.24	2.46	2.82	3.15	4.47	4.89
50.1mw	17			.637	.897	1.23	1.58	2.52	2.76	3.17	3.54	4.80	5.50
63.1mw	18		.502	.714	1.00	1.38	1.77	2.81	3.09	3.55	3.97	5.63	6.15
79.4mw	19		.564	.800	1.13	1.54	1.99	3.16	3.46	3.98	4.45	6.31	6.90
.100	20	.565	.632	.897	1.26	1.73	2.23	3.54	3.88	4.47	4.99	7.10	7.74
.126	21	.634	.708	.878	1.42	1.94	2.50	3.97	4.36	5.01	5.60	7.94	8.68
.159	22	.712	.795	1.13	1.59	2.18	2.82	4.45	4.89	5.63	6.30	8.92	9.75
.200	23	.800	.895	1.27	1.79	2.65	3.16	5.01	5.50	6.32	7.06	10.0	10.9
.251	24	.897	1.00	1.43	2.01	2.75	3.54	5.61	6.16	7.08	7.91	11.2	12.3
.316	25	1.00	1.12	1.60	2.24	3.08	3.97	6.30	6.91	7.95	8.89	12.6	13.8
1.000	30	1.79	2	2.84	4	5.48	7.07	11.2	12.3	14.1	15.8	22.4	24.5

POWER Watts / R load (ohms)	dbm	3.2	4	8	16	30	50	125	150	200	250	500	600
2	33	2.52	2.82	4.00	5.64	7.73	9.97	15.8	17.3	20.0	22.3	31.6	34.5
3	34.8	3.10	3.46	4.91	6.92	9.48	12.2	19.4	21.3	24.4	27.3	38.7	42.4
4	36	3.58	4.00	5.68	8.00	11.0	14.1	22.4	24.6	28.2	31.6	4.48	49.0
5	37	4.00	4.48	6.36	8.96	12.3	15.8	25.0	27.5	31.6	35.4	50.2	54.9
6	37.8	4.38	4.90	6.96	9.80	13.4	17.3	27.4	30.0	34.5	38.7	54.9	60.0
7	38.4	4.74	5.30	7.53	10.6	14.5	1.87	29.7	32.6	37.4	41.9	59.4	64.9
8	39	5.06	5.66	8.04	11.3	15.5	20.0	31.7	34.8	40.0	44.7	63.4	69.3
9	39.5	5.37	6.00	8.52	12.0	16.4	21.2	33.6	37.0	42.3	47.4	67.2	73.5
10	40	5.65	6.32	8.97	12.6	17.3	22.3	35.4	38.9	44.5	50.0	70.7	77.4
11	40.4	5.94	6.64	9.42	13.3	18.2	23.5	37.2	40.8	46.8	52.4	74.4	81.3
12	40.8	6.19	6.92	9.82	13.8	19.0	24.5	38.7	42.5	4.88	54.7	77.5	84.8
13	41.1	6.47	7.24	10.3	14.5	19.8	25.6	40.5	44.5	51.0	57.2	81.1	88.7
14	41.5	6.71	7.50	10.6	15.0	20.5	26.5	42.0	46.1	52.9	59.2	84.0	92.0
15	41.8	6.94	7.76	11.0	15.5	21.3	27.4	43.4	47.7	54.7	61.3	86.9	95.0
20	43	8.00	8.96	12.7	17.9	24.5	31.7	50.0	55.1	63.2	70.7	100	110
25	44	8.95	10.0	14.2	20.0	27.4	35.3	56.0	61.5	70.5	79.0	112	122
30	44.8	9.82	11.0	15.6	22.0	30.0	38.8	61.5	67.5	77.4	86.7	123	134
35	45.4	10.6	11.8	16.8	23.7	32.4	41.8	66.3	72.8	83.5	93.5	133	145
40	46	11.3	12.6	17.9	25.3	34.6	44.6	70.7	77.7	89.1	100	141	155
45	46.5	12.0	13.4	19.1	14.9	36.8	47.5	75.3	82.6	94.7	106	150	165
50	47	12.6	14.1	20.1	28.3	38.7	50.0	79.2	87.0	100	112	158	173
60	47.8	13.9	15.5	22.0	31.0	42.5	54.8	86.8	95.3	109	122	174	190
70	48.4	15.0	16.7	23.4	33.5	45.9	59.2	93.7	103	118	132	187	205
80	49	16.0	17.9	25.4	35.8	49.0	63.3	100	110	126	141	200	219
90	49.5	17.0	19.0	27.0	38.0	52.1	67.2	106	117	134	150	213	233
100	50	17.9	20.0	28.4	40.0	54.8	70.7	112	123	141	158	224	245

SECTION III

CIRCUIT DESCRIPTION

AC VTVM

The voltage measured by the A-C VTVM, whether applied externally to the INPUT binding posts or derived internally, is routed to it by the FUNCTION switch S1. On the lower six range positions of the METER RANGE switch S2, the voltage being measured is coupled directly to the grid of a cathode follower V3A. On the four highest range positions, the voltage is attenuated 60db (1000:1) by a frequency-compensated attenuator before it is coupled to the cathode follower grid. In the output circuit of the cathode follower, there is a six tap voltage divider. Out of this divider, the voltage is fed to a two-stage R-C coupled amplifier, V3B and V5A. The amplifier output is fed to a full-wave bridge rectifier with the meter connected as the load. From the opposite side of the bridge, there is a degenerative feedback network back to the cathode of the first amplifier. The calibration control R36 is incorporated in the feedback network.

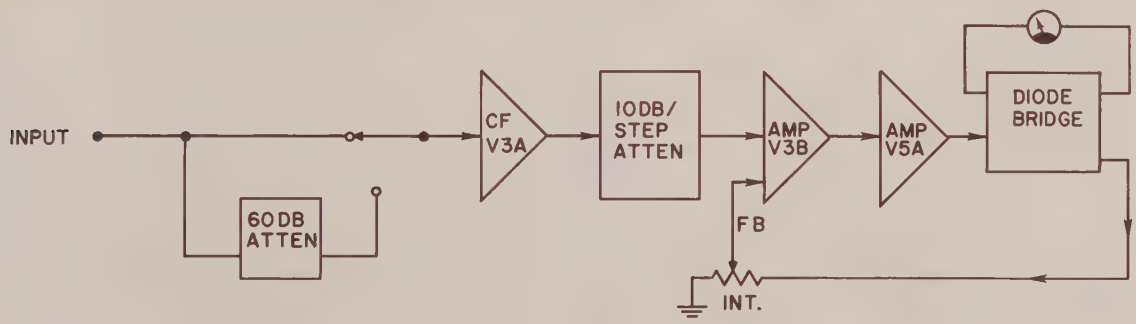


Figure 3-1

IM DISTORTION METER

The HF (high frequency) and LF (low frequency) two-tone signal is generated by mixing the output of a 7kc Colpitts oscillator, V9, with a well-filtered power line frequency signal taken from the secondary winding of the power transformer. If desired, either or both tones may be obtained from external audio sinusoidal sources connected to the EXT LF jack J6 and the EXT HF jack J7. The LF signal is adjusted by LF LEVEL control P1 to equal the full HF signal amplitude. The mixing is done in a bridge circuit, which prevents interaction between the two sources and the development of false intermodulation. The LF:HF amplitide ratio may be 4:1 or 1:1, the change in ratio being accomplished by the insertion of a 12db pad between the HF oscillator and the mixing bridge (IM 4:1 - IM 1:1 switch S6). The output of the bridge is fed through a 600Ω L-pad attenuator R85 to the OUTPUT binding posts, which are connected to the input of the unit under test. The output of the unit under test is connected to the INPUT binding posts and routed by FUNCTION switch S1 at the IM position to the IM distortion measurement section V6A & B, V5B & C, which amplifies the HF signal (any frequency above 2kc), but rejects the LF signal (any frequency below 400 cps). The HF "carrier" signal, if there is intermodulation distortion, will have a modulation envelope. This modulation HF "carrier" signal is set by the IM CAL control R43 to the 30% reading which is the pre-determined calibration level, and is then detected. The detected signal is applied to a low-pass filter which removes the "carrier" and passes only the low frequency modulation envelope, which is the sum of the intermodulation distortion components. The latter is applied to the a-c vtvm section and read on the meter as % IM distortion.

The A-C VTVM section is used:

to indicate HF level before mixing at HF
to indicate LF level before mixing at LF
to indicate level of distorted HF "carrier" at CAL
to indicate percentage distortion at %

} OPERATION switch positions

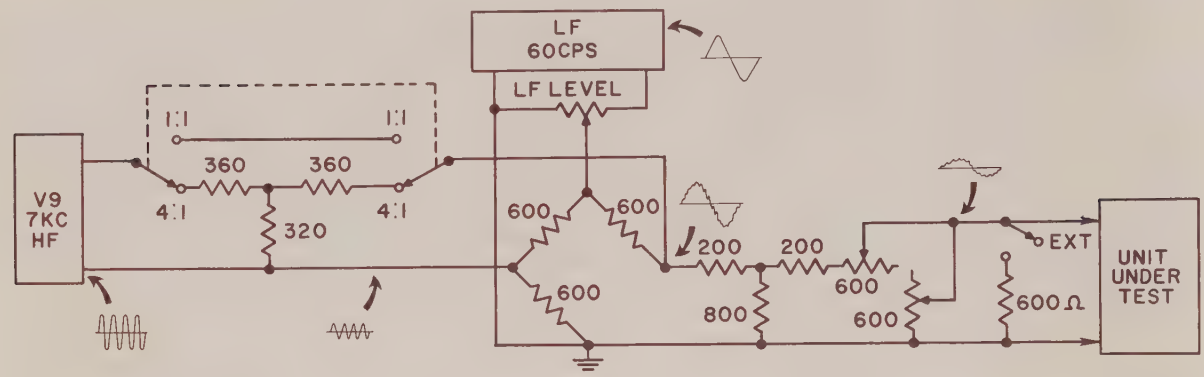


Figure 3-2

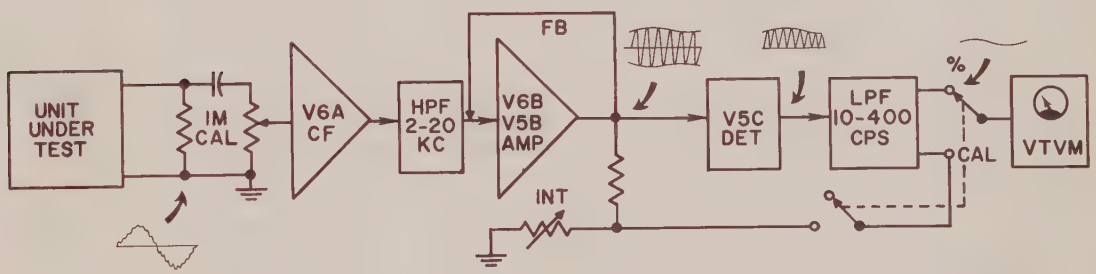


Figure 3-3

HARMONIC DISTORTION METER

The distorted single frequency output of the device under test is applied to the INPUT binding posts. The fundamental frequency of the signal may be anywhere between 20 and 20,000 cps and is obtained from an external sinusoidal audio signal source applied to the input of the test device. The distorted signal is routed by FUNCTION switch S1 at the HD position to the HD analysis section V1A, V2, V4, and V1B. At the CAL position of the OPERATION switch S4, the distorted signal is amplified and measured on the A-C VTVM. The level of the distorted signal is adjusted by the HD CAL control R1 to obtain the 100% reading which is the calibration level. At this point, the Wien bridge rejection filter is introduced to reject the fundamental frequency of the distorted signal. The HD RANGE switch S3 is used to select the range in which the fundamental falls, and the HD NULL control C8 is used to fine tune to exactly the fundamental frequency. The HD BALANCE control R11 is used to balance the bridge as closely as possible to obtain the maximum fundamental rejection. The signal that remains after the fundamental is rejected is the sum of the actual distortion components and is measured on the a-c vtvm in % harmonic distortion. The SCOPE binding post J3 permits connection of an oscilloscope for observation of the distortion components.

The A-C VTVM is used:

to indicate the level of the distorted signal at "CAL"
to indicate percentage distortion at "%"

{ OPERATION switch positions

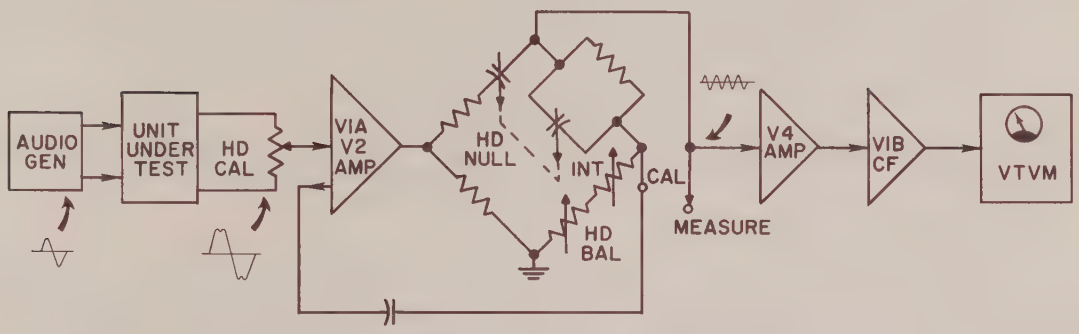


Figure 3-4

POWER SUPPLY

The power supply incorporates a full-wave tube rectifier, V7, a pi-type RC filter, and a voltage regulator tube V8, that provides regulated B+ voltage for the A-C VTVM stages and harmonic distortion measurement stages. A hum balance potentiometer R52, is connected across the filament winding. The B+ voltage is applied, through a voltage divider, to the arm of the hum-balance potentiometer. This d-c voltage is applied to the tube filaments and creates a saturation heater-cathode leakage current which bars heater-cathode leakage hum.

Service:
ELECTRO SERVICE CO.
1821 UNIVERSITY AVE.
BERKELEY 44, CALIF.

SECTION IV

MAINTENANCE

4-1. GENERAL

Your instrument will normally require little service outside of tube replacement. The performance of the instrument is not dependent on tube selection and all of the types employed are available nationally.

All of the required adjustment procedures are described in this section. Trouble-shooting information is provided also. Operating voltages and transformer winding resistances are shown on the schematic diagram. In reading the schematic diagram, it may be found helpful to refer to the Block Diagrams.

4-2. CASE REMOVAL

Loosen and remove the two sheet metal screws at the rear. Slide the case out of the panel frame and off the instrument.

4-3. METER MECHANICAL ZERO ADJUST

The meter pointer should rest directly over the zero of the voltmeter scales when the POWER switch is at OFF (power off). If the meter pointer comes to rest at a deflected position, adjust it to zero by turning the slotted screw directly beneath the meter face.

NOTE: For any or all of the following adjustments, allow the instrument to warm up for at least five minutes.

4-4. HUM BALANCE ADJUST

Remove the case and set the METER RANGE switch at 1MV. Turn the instrument on. Adjust the hum balance control R52 for minimum deflection of the meter pointer.

4-5. CALIBRATION ADJUST

Potentiometer R36 in the amplifier feedback loop is provided for calibration adjustment of the instrument. The AC power line voltage is used as a known voltage for the adjustment. If possible, use a known accurate instrument to measure the line voltage accurately at the time of calibration.

To make the adjustment, remove the plug button on the left side of the case. The shaft of the calibration control R36 is accessible through this hole. The control has a slotted shaft to permit screwdriver adjustment. (The control located in Fig. 4-2.)

Set the FUNCTION switch at VTVM, and the METER RANGE switch at 300V. Connect leads from the INPUT binding posts across the AC power line. Keep in mind that there is a 50% chance of the instrument chassis being connected to the "hot" side of the line, and exercise due caution. As stated previously, check the line voltage with a known accurate instrument, if possible. Now set the calibration control R36 so that the meter reads either the measured value of the line voltage, or the nominal value of the line voltage if no accurate measurement is possible. This completes the calibration adjustment.

4-6. ATTENUATOR FREQUENCY COMPENSATION ADJUST

Trimmer capacitor C5, fixed capacitor C6, and resistors R5 and R6 comprise a 60db (1000:1) attenuator. Trimmer C5 must be adjusted by the following method so that the voltage division will be constant throughout the frequency range of the instrument.

To make the adjustment, the case must be removed. The trimmer C5 adjustment is accessible on the bottom side of the chassis off the METER RANGE switch S2. (See Fig. 4-2.)

Set the FUNCTION switch at VTVM, and the METER RANGE switch at 3V. Connect an audio generator to the INPUT binding posts, and set the generator frequency to 150kc. Adjust the generator output for a reading of 3 volts (full-scale) on the 902 meter. Then set the METER RANGE switch at 10V, and adjust trimmer C5 with an alignment tool, for a reading of exactly 3 volts on the 10V range. This completes the frequency compensation adjustment.

4-7. HARMONIC DISTORTION MEASUREMENT ADJUSTMENTS

There are three adjustments required, namely that of R8 (Fig. 4-2), C8 and C9 (Fig. 4-3.) An audio generator is required for the adjustments. A step-by-step procedure follows.

1. Turn 902 and audio generator on, and allow 5-minute warm-up.

2. Set FUNCTION sw. at VTVM, METER RANGE sw. at 1V.

3. Connect audio generator output to INPUT terminals and set at 2kc.

4. Adjust audio generator output level for 1V reading on meter.

5. Set FUNCTION sw. to HD, METER RANGE sw. to HD CAL, OPERATION sw. to CAL, HD BALANCE pot. to center of rotation.

6. Adjust IM/HD CAL pot for full-scale reading on 0-1 scale.

7. Set HD RANGE sw. to 2K-20K, OPERATION sw. to %, HD NULL control to 20 on dial.

8. Adjust pot R8 for minimum reading on lowest possible range setting of the METER RANGE switch.

9. Without altering audio generator frequency or output level, set HD RANGE sw. to 200-2K, HD NULL to 200.

10. Adjust trimmers C8 and C9 alternately for minimum meter reading on lowest possible range setting of the METER RANGE switch.

NOTE: Repeat steps 7 through 9 several times, or until no further improvement can be detected.

4-8. INTERMODULATION DISTORTION MEASUREMENT ADJUSTMENTS

There is only one adjustment required, namely that of potentiometer R-66 (Fig. 4-3.) The following equipment and materials are required: An audio generator, two 10KΩ, 1W resistors, and one 6.8KΩ, 1W resistor (resistors ±10% accuracy or better). The connections are made in accordance with Fig. 4-1. and a step-by-step procedure follows.

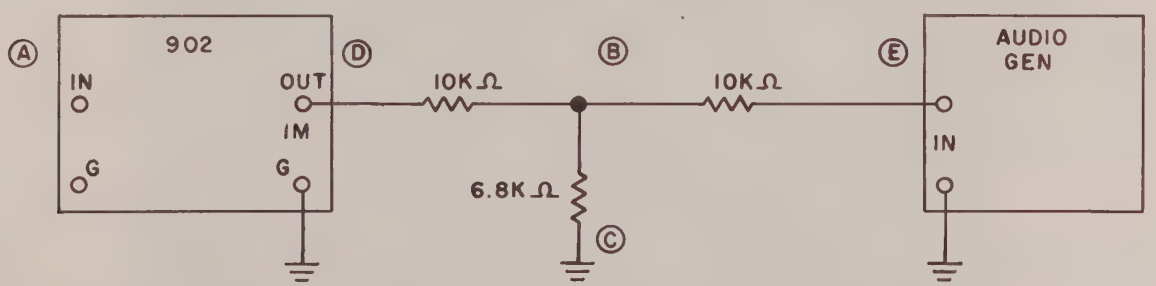


Figure 4-1

1. Turn 902 and audio generator on, and allow 5-minute warm up.

2. Set OPERATION sw. to %, FUNCTION sw. to VTVM, METER RANGE sw. to 3V, LF LEVEL to MIN (max. ccw rotation), IM OUTPUT control to 10, IM RATIO sw. to 1:1, 600Ω EXT sw. to 600Ω.

3. Short B & C. Connect D to A and read value of 7kc signal from 902 OUTPUT terminals on meter scale. Note reading exactly. Disconnect D from A.

4. Retain short from B to C. Connect E to A and set audio generator to 7kc. Adjust audio generator output level for same meter reading as found in step 3. Disconnect E from A.

5. Remove short from B to C. Connect B to A. Turn audio gen. frequency control slowly through the 7kc dial calibration watching the 902 meter for the appearance of a beat note between

the audio gen. and 902 outputs. The beat note is indicated by an oscillation of the meter pointer as zero beat is approached. Zero beat is indicated by the longest period of oscillation. The audio generator frequency should be set at this point.

6. Short B to C. Connect E to A. Set the audio generator frequency to a point either 100 cps above or below on the dial from the zero beat point. Set 902 METER RANGE switch to 0.3V and adjust audio generator output level for reading at same scale point obtained in step 3 above. Effectively, this means that the audio generator output (at either 6900 or 7100 cps) is precisely 10% of the pure 7kc output from the 902 and that the mix of the two signals is a signal having exactly 10% IM distortion. Disconnect E from A.

7. Remove short from B to C. Connect B to A. Set FUNCTION sw. to IM, OPERATION sw. to %, METER RANGE switch to 10%. Adjust IM/HD CAL. control for full-scale reading on 0-1 scale. Do not touch IM/HD CAL. control thereafter.

8. Set OPERATION sw. to CAL. Set METER RANGE sw. to 30% (IM CAL). Adjust potentiometer R66 for full-scale reading on 0-3 scale. This completes the adjustment of R66.

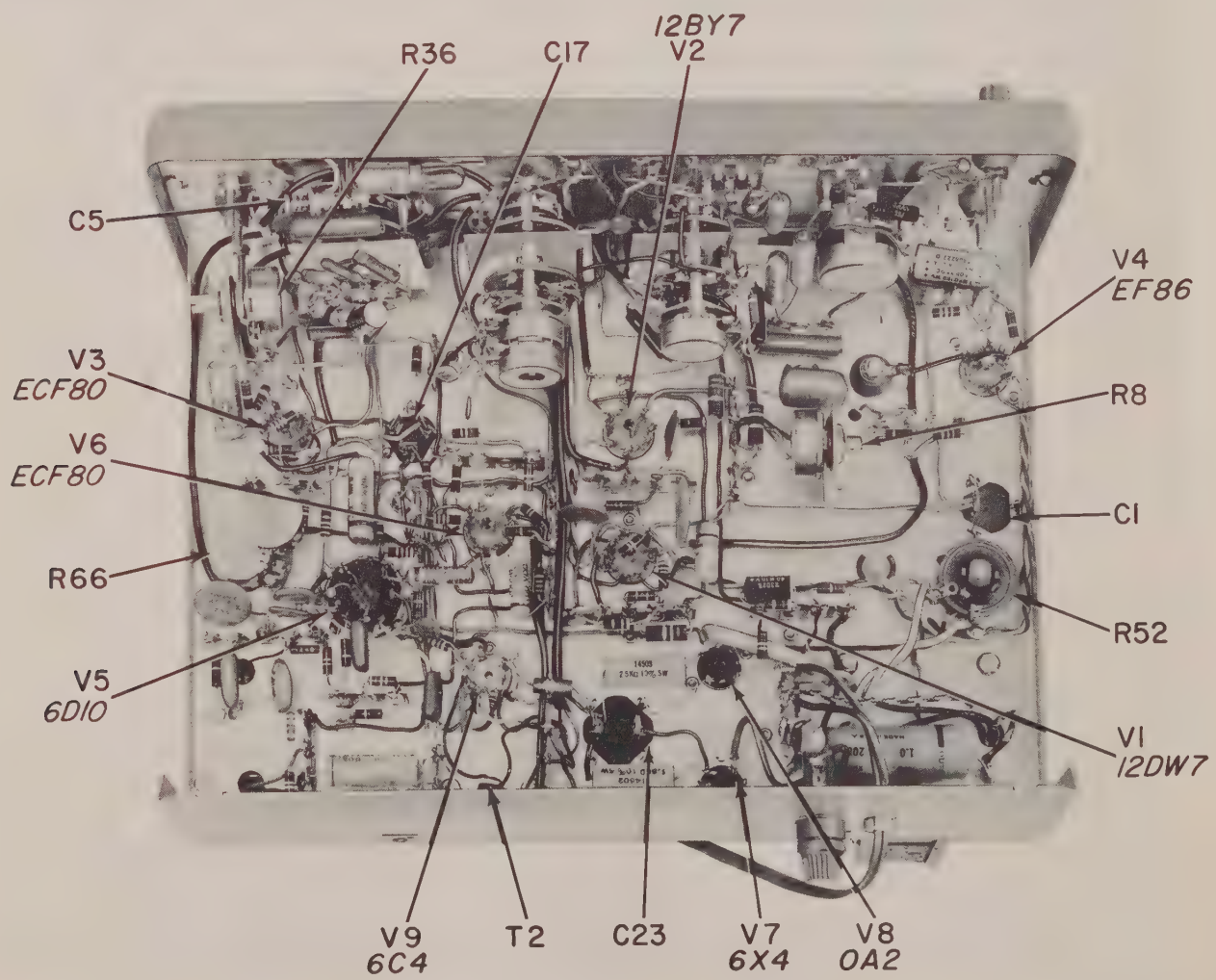


Figure 4-2. Bottom Chassis View

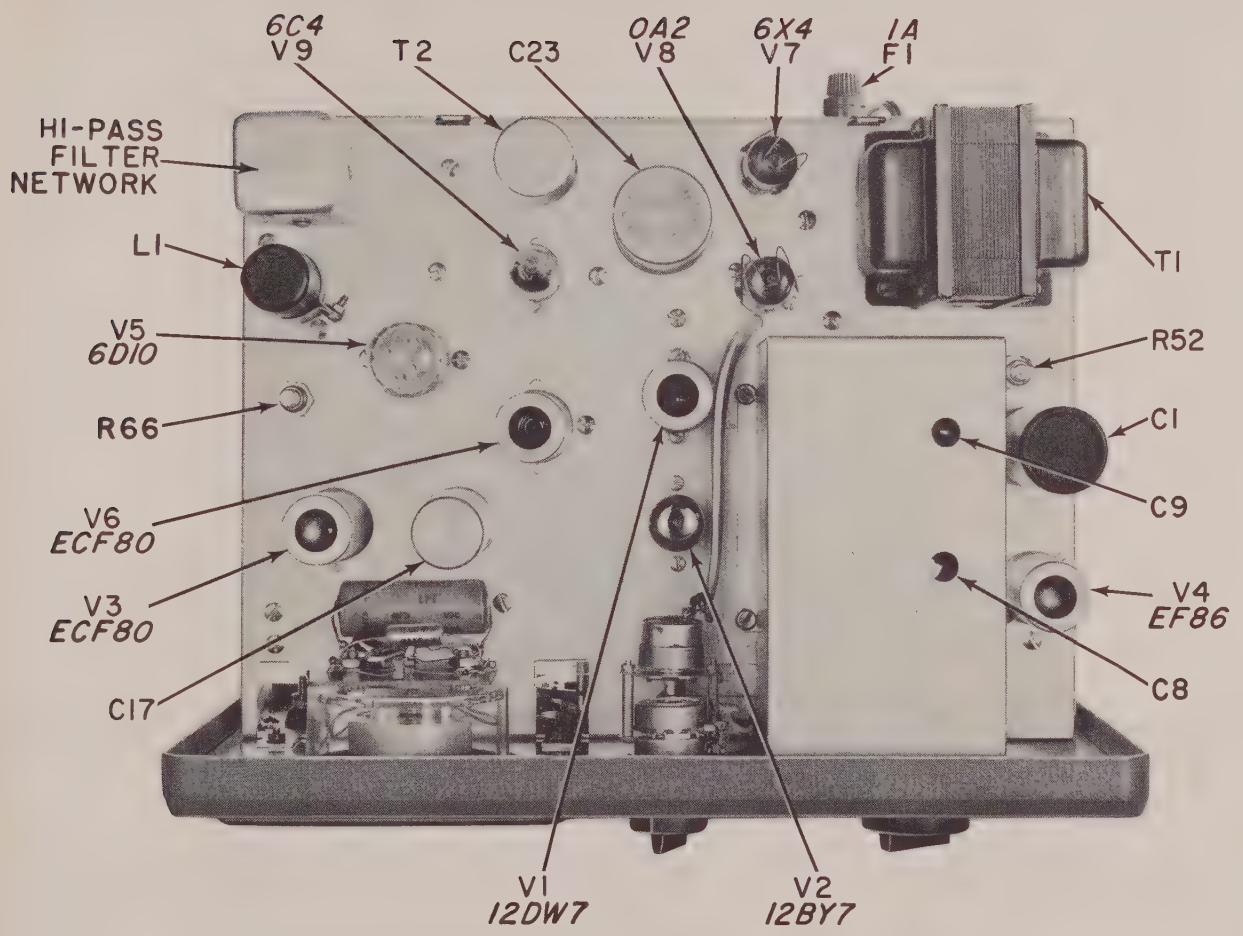


Figure 4-3. Top Chassis View

SYM. #	STOCK#	AM'T.	DESCRIPTION
CAPACITORS			
C1	24023	1	capacitor, elect., can 300ufd, 150V
C2, 3, 4,	22510	3	capacitor, disc, .02ufd, GMV
C5	29513	1	capacitor, trimmer, 1.5-6uuf
C6, 36	22562	2	capacitor, disc, .005ufd, 10%
C7	20057	1	capacitor, mylar, .47ufd, 200V
C8, 9	29507	2	capacitor, trimmer, 5-80uuf
C10	29023	1	capacitor, tuning, 2 x 540uuf
C11, 27	23025	2	capacitor, elect., 40ufd, 10V
C12	23048	1	capacitor, elect., 1ufd, 150V
C13, 15	22519	2	capacitor, disc, .01ufd, 10%

SYM. #	STOCK#	AM'T.	DESCRIPTION
C14	20000	1	capacitor, paper, .01ufd, 400V
C16	23044	1	capacitor, elect., 300ufd, 3V
C17	24016	1	capacitor, can, 2 x 20ufd, 300V, 2ufd
C18, 26	20056	2	capacitor, paper, 1ufd, 200V
C19	22508	1	capacitor, disc, .0033ufd, 500V, 10%
C20	23063	1	capacitor, elect., paper, 40ufd, 3V
C21	22504	1	capacitor, disc, .002ufd, GMV
C22	22521	1	capacitor, disc, .001ufd, 10%
C23	24026	1	capacitor, elec., 2 x 30ufd, 400V
C24	20002	1	capacitor, paper, .002ufd, 400V
C25	20058	1	capacitor, mylar, .1ufd, 100V
C28	22515	1	capacitor, disc, 500uuf, 10%
C29, 30, 31	20059	3	capacitor, mylar, .033ufd, 10%
C32	22530	1	capacitor, disc, .006ufd, 10%
C33	20063	1	capacitor, mylar, .03ufd, 5%
C34	20083	1	capacitor, mylar, .02ufd, 10%
C35	22560	1	capacitor, disc, .05ufd, GMV
C37	20069	1	capacitor, paper, .047ufd, 200V

DIODES

CR1, 2, 3, 4	95005	4	diode, crystal, HD2257

FUSE

F1	91002	1	fuse, 1 Amp

BULB

I1	92000	1	bulb, No. 47

JACKS

J1, 3, 4	52006	3	binding post assembly
J2, 5	52008	2	binding post ground assembly
J6, 7	50010	2	jack

COILS

L1	34006	1	choke, 10h
	33000	1	filter, Hi-Pass

METER

M1	72012	1	meter, 200mA

SYM#.	STOCK#	AM'T.	DESCRIPTION
RESISTORS			
R1, 43		1	potentiometer, dual, 500KΩ (on S1)
R2, 70	10402	2	resistor, 10MΩ, 1/2W, 10%
R3	10410	1	resistor, 100KΩ, 1/2W, 10%
R4, 37, 86	10430	3	resistor, 4700Ω, 1/2W, 10%
R5	10705	1	resistor, 2MΩ, 1W, 1%
R6	11011	1	resistor, 2000Ω, 1/2W, 1%
R7	10967	1	resistor, 2500Ω, 2W, 10%
R8	19020	1	potentiometer, 1000Ω, linear, 1 watt
R9	10860	1	resistor, 680Ω, 1W, 10%
R10	10549	1	resistor, 9.1MΩ, 1/2W, 5%
R11	18099	1	potentiometer, 150Ω, dual, linear
R12	10863	1	resistor, 220Ω, 1W, 10%
R13, 14	11095	2	resistor, 160KΩ, 1/2W, 1%
R15, 16	11091	2	resistor, 1.6MΩ, 1/2W, 1%
R17, 18	11717	2	resistor, 16MΩ, 1W, 1%
R19	10832	1	resistor, 27KΩ, 1W, 10%
R20	10413	1	resistor, 2700Ω, 1/2W, 10%
R21	10439	1	resistor, 100Ω, 1/2W, 10%
R22, 58, 59	10407	3	resistor, 1MΩ, 1/2W, 10%
R23	10421	1	resistor, 6800Ω, 1/2W, 10%
R24	10422	1	resistor, 68KΩ, 1/2W, 10%
R25, 49, 63	10442	3	resistor, 1500Ω, 1/2W, 10%
R26	10419	1	resistor, 270KΩ, 1/2W, 10%
R27, 40, 62	10428	3	resistor, 47KΩ, 1/2W, 10%
R28	11069	1	resistor, 6838Ω, 1/2W, 1%
R29	11070	1	resistor, 2162Ω, 1/2W, 1%
R30	11071	1	resistor, 683.8Ω, 1/2W, 1%
R31	11072	1	resistor, 216.2Ω, 1/2W, 1%
R32	11073	1	resistor, 68.38Ω, 1/2W, 1%
R33	11074	1	resistor, 31.62Ω, 1/2W, 1%
R34	10426	1	resistor, 33KΩ, 1/2W, 10%
R35, 51	10456	2	resistor, 820Ω, 1/2W, 10%
R36	16003	1	potentiometer, 150Ω, linear
R38	10457	1	resistor, 3.3MΩ, 1/2W, 10%
R39, 45, 46 47, 48	10400	5	resistor, 10KΩ, 1/2W, 10%
R41	10463	1	resistor, 220Ω, 1/2W, 10%
R42	10411	1	resistor, 5.6MΩ, 1/2W, 10%
R44	10409	1	resistor, 560KΩ, 1/2W, 10%
R50	10406	1	resistor, 680Ω, 1/2W, 10%
R52	19013	1	resistor, W.W., 35Ω
R53	10412	1	resistor, 330KΩ, 1/2W, 10%
R54	10427	1	resistor, 1200Ω, 1/2W, 10%
R55	10432	1	resistor, 1000Ω, 1/2W, 10%
R56	14502	1	resistor, 1800Ω, 5W, 10%
R57	14503	1	resistor, 2500Ω, 5W, 10%
R60, 61, 71	10431	3	resistor, 470KΩ, 1/2W, 10%
R64		1	potentiometer, 1000Ω, (on S4)
R65	10435	1	resistor, 150KΩ, 1/2W, 10%
R66	18112	1	potentiometer, 100KΩ, linear
R67	10853	1	resistor, 10KΩ, 1W, 10%
R68	10539	1	resistor, 6200, 1/2W, 5%

SYM. #	STOCK#	AM'T.	DESCRIPTION
R69	10424	1	resistor, 22KΩ, 1/2W, 10%
R72	11103	1	resistor, 560Ω, 1/2W, 1%
R73, 74, 75, 76	11101	4	resistor, 600Ω, 1/2W, 1%
R77	10444	1	resistor, 120KΩ, 1/2W, 10%
R78	10438	1	resistor, 330Ω, 1/2W, 10%
R79	11104	1	resistor, 320Ω, 1/2W, 1%
R80, 81	11105	2	resistor, 360Ω, 1/2W, 1%
R82	11107	1	resistor, 800Ω, 1/2W, 1%
R83, 84	11106	2	resistor, 200Ω, 1/2W, 1%
R85	19021	1	potentiometer, 600Ω, Type L

SWITCHES

S1	60110	1	switch, rotary/dual 500KΩ pot
S2	60117	1	switch, rotary
S3	60109	1	switch, slide (attn.)
S4	60111	1	switch, rotary/1KΩ pot
S5	60114	1	switch, SPST/throw
S6	62012	1	switch, slide DPDT
S7	62015	1	switch, slide, SPST

TERMINAL STRIPS

TB1	54004		terminal strip, 2 post/ground
TB2, 12	54018	2	terminal strip, 4 post/ground
TB5, 11, 15, 17	54015	4	terminal strip, 3 post, 2 left/ground
TB4	54013	1	terminal strip, 1 post, left/ground
TB3	54014	1	terminal strip, 3 post, 2 left
TB6, 7	54005	2	terminal strip, 2 post, right/ground
TB8	54002	1	terminal strip, 1 post, right/ground
TB9, 13	54025	2	terminal strip, 4 post, 3 right
TB10	54024	1	terminal strip, 2 post, left
TB14	54007	1	terminal strip, 3 post, 2 right/ground
TB16	54003	1	terminal strip, 2 post
TB18	54023	1	terminal strip, 2 post, left/ground
TB19	82500	1	terminal board, Meter

TUBES

V1	90061	1	tube, 12DW7
V2	90064	1	tube, 12BY7
V3, 6	90071	2	tube, ECF80/6BL8
V4	90042	1	tube, EF86
V5	90081	1	tube, 6D10
V7	90036	1	tube, 6X4
V8	90074	1	tube, OA2
V9	90002	1	tube, 6C4

SYM. #	STOCK#	AM'T.	DESCRIPTION

SOCKETS

XF1	97805	1	fuseholder
XI1	97712	1	socket, pilot light
XV1, 3, 4, 6	97027	4	socket, tube, 9 pin, top mount
XV2	97039	1	socket, tube, 9 pin, bottom mount
XV5	97064	1	socket, tube, 12 pin compactron
XV7, 8	97062	2	socket, tube, 7 pin, top mount
XV9	97022	1	socket, tube, 7 pin, bottom mount

HARDWARE

40000	26	nut, No. 6-32
40001	11	nut, 3/8"
40007	21	nut, No. 4-40
40008	7	nut, No. 8-32
40016	1	nut, 1/2"
40017	2	nut, No. 8, Tinnerman
40034	4	nut, No. 4-40, Tinnerman
40038	2	nut, 1/4"
41035	4	screw, No. 6-32 x 1/4 P.K.
41066	6	screw, No. 8-32 x 5/16
41069	4	screw, set, No. 6 x 1/8
41086	22	screw, No. 6-32 x 5/16
41089	12	screw, No. 6-32 x 3/16, Rd. Hd.
41090	18	screw, No. 4-40 x 5/16
41091	5	screw, No. 4-40 x 1/4, Fl. Hd.
41101	1	screw, No. 6-32 x 1"
41116	2	screw, No. 8-32 x 5/8 (nylon)
41122	1	screw, No. 8-32 x 3/8
41123	1	screw, No. 8-32 x 7/8, Rd. Hd.
42000	6	washer, lock, 3/8"
42001	6	washer, flat, 3/8"
42002	28	washer, lock, No. 6
42007	19	washer, lock, No. 4
42008	6	washer, lock, No. 8
42017	1	washer, fiber
42029	1	washer, rubber, 1/2"
42034	1	washer, fibre, No. 6
42040	2	washer, flat, 1/4" fibre
42047	2	washer, shoulder, 1/4" fibre
42049	2	washer, flat, 1/4"
42060	4	washer, shoulder
42061	4	washer, flat, No. 8 for 42060
42514	2	retainer, spring for 7 pin
43000	1	lug, ground, No. 6
43001	2	lug, ground, 3/8"
43004	8	lug, solder, No. 8
43006	2	lug, ground, No. 4
45003	1	standoff, No. 8-32

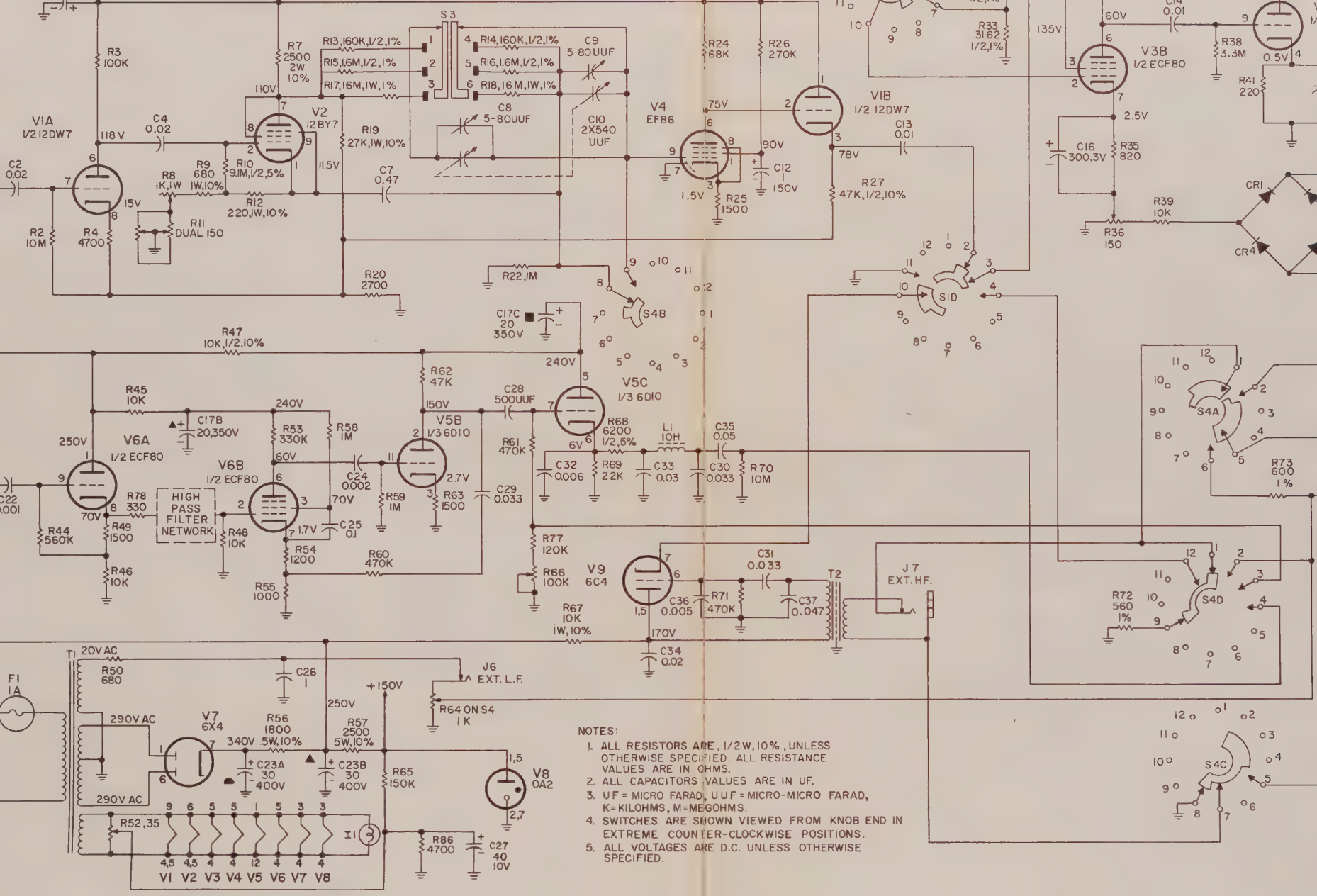
STOCK#	AM'T.	DESCRIPTION

SHEET METAL

80129	1	panel, front
81914	2	bracket, pot
81952	1	shield, variable cap.
81953	1	chassis
81956	1	bracket, choke
86007	1	frame
88112	1	cabinet

MISCELLANEOUS

46016	4	foot, plastic, grey
47009	1	spring
53036	3	knob, 1 1/16"
53040	3	knob, concentric, outer
53041	3	knob, concentric, inner
53038	1	knob, 2"
57004	1	linecord
82104	1	linecord, strain relief
83004	1	coupling, nylon ext.
84000	1	drive, vernier
87007	1	handle, plastic
89272	1	label, nomenclature
89679	2	bracket, top handle
89680	2	bracket, bottom handle
89698	1	dial, plastic
97300	4	shield, 9 pin
97720	1	jewel, pilot light
66121	1	instruction manual



NOTES:

1. ALL RESISTORS ARE, 1/2W, 10%, UNLESS OTHERWISE SPECIFIED. ALL RESISTANCE VALUES ARE IN OHMS.
2. ALL CAPACITORS VALUES ARE IN UF.
3. UF = MICRO FARAD, UUF = MICRO-MICRO FARAD, K=KILOHMS, M=MEGOHMS.
4. SWITCHES ARE SHOWN VIEWED FROM KNOB END IN EXTREME COUNTER-CLOCKWISE POSITIONS.
5. ALL VOLTAGES ARE D.C. UNLESS OTHERWISE SPECIFIED.

Model 902. Schematic Diagram

EICO
Service Policy

PARTS REPLACEMENT

If it appears that a component is defective, and you desire a replacement, contact your nearest EICO Authorized Service Agency or our Customer Service Department.

If you are claiming the right to a no-charge replacement under the terms and conditions of the warranty, it is required that you shall have sent in the registration card within 10 days of the date of purchase, and that you send back the defective part transportation prepaid. In claiming warranty service or parts, please send or show your **original sales slip** plus the IBM card from the carton. EICO or its authorized agency will make the necessary replacement at no charge for parts eligible under the terms and conditions of the warranty. In returning tubes, pack them very carefully to avoid breakage in shipment. Broken tubes will not be replaced. Please read the warranty on the subject of parts eligible for replacement.

Further information required on a part returned for a no-charge replacement under the terms and conditions of the warranty is as follows:

a) Model number and serial number, if any, of unit. Also any code numbers in red under the words INSTRUCTION MANUAL on the cover of the book supplied with the unit.

b) Stock number and description of part as given on the parts list. If the part is not listed (of itself) in the parts list, it means that the part is integral with a sub-assembly. If the sub-assembly is not sealed, and the defective part is definitely identified and easily replaceable (not more than two connections), you may request replacement for the particular part. If the sub-assembly is sealed, or if the defective part is not definitely identified or is not easily replaceable (more than two connections), then remove the sub-assembly and return it (less any tubes) for repair or replacement, if your unit is in warranty. If your unit is out of warranty, you are generally advised to order a replacement sub-assembly.

c) Describe as completely as possible the nature of the defect, or reason for requiring replacement.

REPAIR SERVICE

EICO maintains a national network of authorized service agencies for in-warranty or out-of-warranty repair of EICO equipment. It is intended to serve those customers who are not sufficiently familiar with electronics to make use of the EICO Service Consultation facilities, or whose difficulties cannot be solved by correspondence.

For all out-of-warranty units, there is a minimum labor and handling fee. Charges for parts replaced are additional to the minimum fee.

For in-warranty completed kit units, there is a minimum labor and handling fee. There is no charge for a replaced defective part provided that the terms and conditions of the warranty for no charge replacement are not violated in the judgement of EICO.

For in-warranty factory-wired units, there is no charge for labor or parts if the unit complies with the terms and conditions of the warranty in the judgement of EICO. However, if the terms and conditions of the warranty are violated there will be a charge for labor plus parts.

In all cases, the unit must be sent to the factory or service agency transportation prepaid, and the unit will be returned to the customer transportation collect.

On kits, the services rendered for the minimum labor and handling fee are the correction of any minor wiring errors (not extensive corrections or rewiring), the labor involved in replacing defective parts, and any adjustments, alignment, or calibration procedures that would normally be performed on a factory-wired unit. Units not wired according to instructions, or modified in any way, or showing evidence of the use of acid core solder, will not be serviced and will be returned to the customer forthwith.

SEE OUR SCHEDULE OF SERVICE CHARGES

Units requiring extensive corrections or rewiring will incur an additional labor charge. An advance estimate will be submitted.

Please note: minimum labor and handling fees and service charges are subject to revision at any time.

LOCAL REPAIR FACILITIES

A list of authorized service stations is provided with this manual. The roster of stations may change from time to time, and if considerable time has elapsed since you purchased your unit, you are advised to contact the station you choose before sending the unit to them for repair. Use of a local service station will often result in faster service, and, usually, lower transportation costs.

It is necessary that you comply with the Shipping Instructions that follow when sending in a unit for service.

SHIPPING INSTRUCTIONS

You are strongly advised to retain the original shipping carton and inserts should reshipment be required for service or any other purpose. The carton may be collapsed for storage in as small a space as possible. In very many cases, the same carton is used for kit and factory-wired units so that the kit carton will serve for reshipment of the completed kit.

When sending a unit for service pack the unit very carefully, preferably in the original shipping carton **with the original inserts.**

If this is not possible, use a strong oversize carton, preferably wood, and using at least 3 inches of resilient packing material such as shredded paper or excelsior inserted between all sides of the unit and the carton. Seal the carton with strong gummed paper tape or strong twine or both. Attach a tag to the instrument on which is printed your name and address and brief reference to the trouble experienced. Affix "FRAGILE" or "HANDLE WITH CARE" labels to at least four sides of the carton or print these words large and clear with a bright color crayon. Ship prepaid.

Include your name and address on the outside of the carton. Return shipment will be made transportation charges collect. Note that a carrier cannot be held liable for damage in transit, if packing, IN HIS OPINION, is insufficient.

THE EICO WARRANTY

The Electronic Instrument Company, Inc., hereafter referred to as EICO, warrants that, for a period of 90 days from the date of purchase, any EICO kit will be free of defects in parts, and that any EICO factory-wired unit will be free of defects in parts and workmanship. For an EICO kit, EICO's obligation is limited to those parts which are returned transportation prepaid to the factory or authorized service agency without further damage, and in the judgement of EICO are either originally defective or have become defective in normal use. EICO's obligation does **not** include any labor required to locate trouble in or repair a kit. For an EICO factory-wired unit, EICO's obligation is limited to replacement or repair, at EICO's option, of those parts, sections, or entire units returned transportation prepaid to the factory or authorized service agency without further damage, and in the judgement of EICO are either originally defective or have become defective in normal use.

The warranty does not apply to any parts damaged in the course of handling, assembling, or wiring by the customer, or damaged due to abnormal usage or in violation of instructions or reasonable practice, or further damaged to a consequential degree in return shipment. Furthermore, the foregoing warranty is made only to the original customer, and is and shall be in lieu of all other warranties, whether expressed or implied, and of all other obligations or liabilities on the part of EICO, and in no event shall EICO be liable for any anticipated profits, consequential damages, loss of time, or other losses incurred by the customer in connection with the purchase or operation of EICO products or components thereof.

The registration card, which accompanies each EICO kit or factory-wired unit, must be filled in and returned to the company within 10 days after the date of purchase. This warranty applies only to registered units.

SCHEDULE OF SERVICE CHARGES

1. Same prices for wired units or completed kits.
2. Charges are based on the schedule of minimum charges above. Some exceptions are noted below.
3. If the published rate is $ 5.00-$ 6.00, this covers up to 1 hour of labor time (minimum $5.00).
   If the published rate is $ 6.50-$ 8.00, this covers up to 1½ hours.
   If the published rate is $ 9.00-$10.00, this covers up to 2 hours.
   If the published rate is $11.00-$14.50, this covers up to 1½ hours.
   If the published rate is $15.00-$20.00, this covers up to 2½ hours.
4. Time required in excess of these minimum charges is calculated at $5.00 per hour.
5. Above prices are for labor only. Parts are additional.
6. Miscellaneous prices not published in manuals are:
   Probes - $2.00 RP-100 Playback amp. only or
   CRA & CRU - $3.00 Power Supply only
   or Record amp. only ...$5.00
   2536 Printed Circuit Board - $5.00.
7. All prices are subject to change without notice.

MINIMUM LABOR AND HANDLING FEES

AF4	$ 7.50	488	5.00
RA6	5.00	495	5.00
HF12	7.50	526	5.00
HF14	5.00	536	5.00
HF20	10.00	540	5.00
HF22	5.00	555	5.00
HF30	5.00	556	5.00
HF32	9.50	565	5.00
HF35	5.00	566	5.00
ST40	15.00	584	5.00
HF50	5.00	610	5.00
HF52	10.00	612	5.00
HF60	5.00	625	6.00
HF61	6.00	628	7.00
HF61A	6.00	630	5.00
HF65	6.50	632	7.00
HF65A	6.50	666	10.00
ST70	15.00	667	10.00
HF81	13.50	680	6.00
ST84	10.00	706	5.00
HF85	8.00	710	5.00
HF86	9.00	720	13.50
HF87	9.00	722	9.00
HF89	9.00	723	7.50
HFT90	7.50	730	7.50
HFT92	9.00	740	9.00
HFT94	7.50	760	9.00
ST96	13.50	761	9.00
ST97	13.50	762	9.00
MX99	7.50	770	12.00
RP100*	*	771-2	12.00
		777	20.00
145	5.00	803	5.00
145A	5.00	944	5.00
147	5.00	950	5.00
214	6.00	955	6.00
221	6.00	965	15.00
222	7.00	1020	5.00
232	6.00	1050	5.00
249	6.00	1055	5.00
250	7.00	1060	5.00
255	7.00	1064	6.00
260	7.00	1073	5.00
315	6.00	1078	5.00
320	5.00	1100	5.00
322	5.00	1120	5.00
324	5.00	1140	5.00
352	5.00	1171	5.00
360	5.00	1180	5.00
368	12.50	2036	13.50
369	12.50	2050	13.50
377	6.00	2080	13.50
425	6.00	2200	10.00
427	12.50	2400*	
430	12.50	2510	12.00
460	15.00	2536	17.50
470	15.00	2715/16	10.00

* Model RP100 and Model 2400 will be billed on the basis of $10.00 for the first hour and $5.00 each additional hour, with a maximum unauthorized repair of $50.00 for the kit and $25.00 for a wired unit.

LOCAL AUTHORIZED SERVICE STATIONS FOR OUT-OF-WARRANTY REPAIRS

For the convenience of our customers who may prefer to have their units serviced locally, the following repair stations have been franchised and are equipped to service all EICO units:

Alabama

Arnold TV Service
1259 Eslava Drive
Mobile, Alabama

Electro-Mechanical Assoc.
3182 Warrior River Rd.
Hueytown, Alabama

Arkansas

Arkansas Industrial Electronics Co., Inc.
5020 Club Rd.
Little Rock, Arkansas

California

Electronic Instrument Service Co.
8907 S. Vermont Ave.
Los Angeles 44, California

Electro Service Co.
1821 University Ave.
Berkeley, California

United Sound & Television Co.
5036 Venice Blvd.
Los Angeles, California

Colorado

Waltern Ament's Inc.
10 East Colorado Ave.
Colorado Springs, Colorado

Meter-Master Instrument Service
2379 South Downing
Denver 10, Colorado

Mr. Clyde N. Still
2630 W. Kioka
Colorado Springs, Colorado

Connecticut

Vinco Electronics Corp.
Foch Street
Hamden, Conn.

Florida

Southern Auth. Factory Service
62 N.W. 27th Avenue
Miami 35, Florida

Hawaii

Electronic Laboratories
2779 Mokumoa Street
Honolulu 17, Hawaii

Illinois

B & S Electronics, Inc.
6326 W. Roosevelt Road
Oak Park, Chicago, Illinois

Indiana

Lakeland Instrument Labs.
617 E. Randolph Street
Angola, Indiana

Louisiana

Industrial Instrument Works
3328 Magazine Street
New Orleans 15, La.

Maine

Portland T.V. Electronics Co.
283 Cumberland Street
Portland, Maine

Maryland

American Technical & Service
4961 Bethesda Avenue
Bethesda, Maryland

Massachusetts

Park Armature Co.
1218-30 Columbus Ave.
Boston 20, Mass.

Michigan

The Audio Clinic
17125 W. McNichols
Detroit, Michigan

Chase Television Service, Inc.
16311 Grand River
Detroit 27, Michigan

Minnesota

Andersen
4145 Minnehaha Ave., So.
Minneapolis, Minn.

Missouri

Kansas City Calibration Lab.
4034 Broadway
Kansas City, Missouri

Scherrer Instruments
5449 Delmar Blvd.
St. Louis 12, Missouri

Nebraska

Hi-Pix Service
7001 Dodge Street
Omaha, Nebraska

New Jersey

Audio Service Labs.
1422 Springfield Ave.
Irvington, New Jersey

New Hampshire

South East Communications
Walton Road
Seabrook, N.H.

New York

A to Z Television, Inc.
1109 Harlem Road
Cheektowaga 25, N.Y.

Ethical Electronic Service
3330 Hillside Ave.
New Hyde Park, N.Y.

Marveltone Recording Service
1168 Flatbush Avenue
Brooklyn 26, N.Y.

Star Radio & T.V. Co.
3505 James Street
Eastwood Shopping Plaza
Syracuse, New York

Syracuse Instrument Labs.
4895 South Avenue
Syracuse 7, New York

Wide Enterprises, Inc.
612 Union Street
Schenectady 8, N.Y.

North Carolina

Speed Instrument Co.
2718 Rothgeb Drive
P.O. Box 9028
Raleigh, North Carolina

Wayne M. Yelverton
8 Olivet Church Road
Winston-Salem, N.C.

Ohio

Dave's Radio & Television
3112 Upton at W. Central
Toledo 13, Ohio

Electronic Instrument Service Co.
10023 Madison Avenue
Cleveland 2, Ohio

Far Hills Service Center
45 West Whipp Road
Dayton 59, Ohio

Oklahoma

Audio Specialties
1010 North Virginia
Oklahoma City, Oklahoma

Greer's Telefix
528 S. 75 East Ave.
Tulsa 12, Oklahoma

Pennsylvania

Sunshine Scientific Instrument
1810 Grant Ave.
Philadelphia 15, Pa.

Michael's TV & Radio Service
1127 West Chester Pike
Havertown, Pa.

Electronic Servicenter
5354 Germantown Avenue
Philadelphia 44, Pa.

South Carolina

Cayce Radio-T.V. & Appliances, Inc.
906 Knox Abbott Drive
Cayce, South Carolina

Texas

Nelson Electronics Engineering Co.
6329 Gaston
Dallas 14, Texas

Test Equipment Co.
5319 Harlan Drive
El Paso, Texas

B & M Electronic Service
2215 S. Shepherd Drive
Houston 19, Texas

Mundine Radio & Instrument Service
1022 Navarro
San Antonio 5, Texas

Utah

Anderton Electronic Lab.
129 E. 1800 South
Bountiful, Utah

Virginia

Dixie T.V. Service
1107 W. Little Creek Rd.
Norfolk, Va.

Canada

J.R. Tilton, Ltd.
51 McCormack St.
Toronto, Ontario, Canada

New Zealand

John C. Gilbert & Co., Ltd.
Anzac Ave.
Auckland, C.I., New Zealand

These repair stations are authorized to perform out-of-warranty chargeable repair work in accordance with factory standards. In-warranty repairs should be returned to the factory in accordance with the instructions printed in the accompanying manual.

35w = 13.83V
25w = 11.7V
2.5w = 3.7V
250mw = 1.17V

EICO Electronic Instrument Co. Inc.
33-00 Northern Blvd.
L.I.C. 1, New York

MP MASTER
MA35361

SE Laboratories
LOC. EE4
MAN- 05938